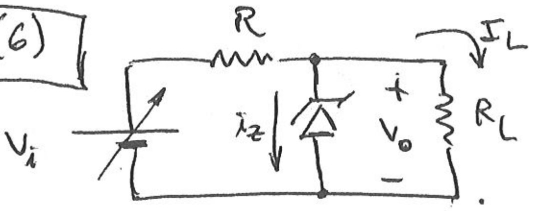
TEST FEBRERO '94

Preg. 1 (6)



$\left\{ \begin{array}{l} I_{L\,min} = 0 \\ I_{L\,max} = 50\,mA \end{array} \right.$

Se desea $V_o = 6{,}8\,V$

Se dispone D1, D2

~~D3~~, D4

$$i_Z = \frac{V_i - V_Z}{R} - I_L$$

$$i_{Z\,max} = \frac{14V - 6{,}8V}{56\,\Omega} - 0 = 128{,}57\,mA \longrightarrow P_{Z\,max} = V_Z \cdot i_{Z\,max} = 874\,mW$$

$$i_{Z\,min} = \frac{10V - 6{,}8V}{56\,\Omega} - 50\,mA = 7{,}14\,mA$$

D1 ⇒ No porque lo destruiríamos

D_3 ⇒ $V_Z = 5{,}6V \longrightarrow$ necesitamos $V_Z = 6{,}8\,V$

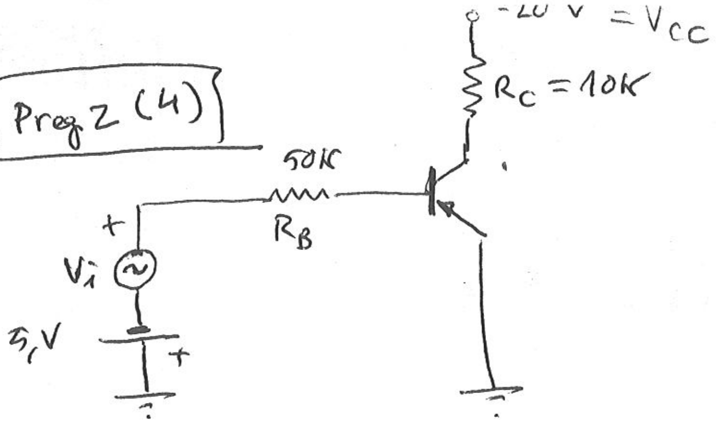
D_2 ⇒ Tampoco

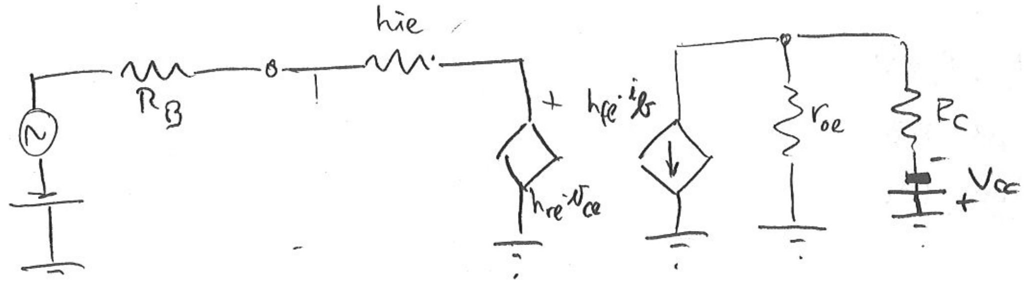
D_4

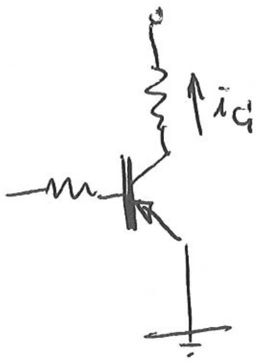
$I_{Z\,max} > i_{Z\,max}$	
↑ fabricante	↑ circuito
$I_{Z\,min} < i_{Z\,min}$	

Preg 2 (4)

$|I_{CQ}| = 10\,mA$







i_c (corriente de colector) es positiva en continua $\Rightarrow$ d) ~~$i_c = (-10 - 5v_i)\,mA$~~

en alterna es negativa

c) $i_C = (10 - 5v_i)\,mA$

$$i_b = \frac{v_i}{50\,k\Omega + h_{ie}}$$

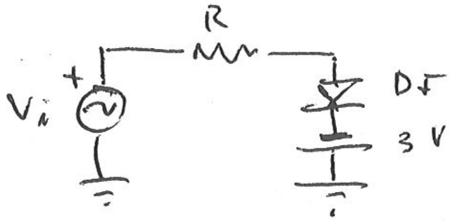
$$i_c = h_{fe} \cdot i_b = K v_i$$

$K > 0$

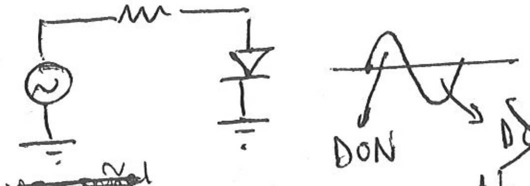
$$\boxed{i_{C'} = I_C - i_c}$$

ELET
25/1/95
(2)

Preg 3 (1)



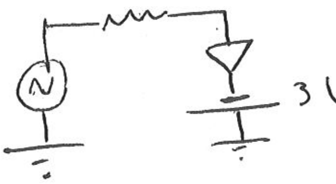
b ó c ? ⇒ (b) / c también válido

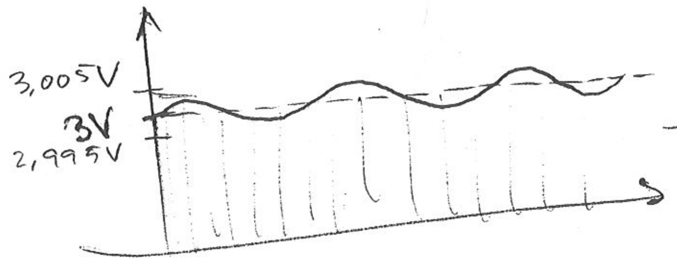


No polarizan en off

D ON

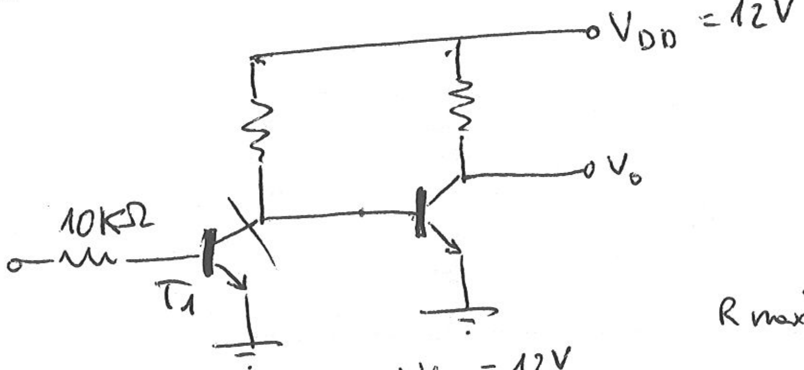
$V_i = 5 \sin \omega t$ (mV)





→ DJ ON siempre!

Preg 4 (3)



$V_{BE} = 0,7V$

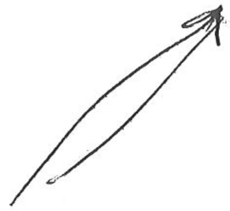
$V_{CEsat} = 0V$

$h_{FE} = \beta = 100$

R_{max}? / $V_o = V_{OL} = 0V$

$\begin{cases} V_{OH} = 12V \\ V_{OL} = 0V \end{cases}$

T1 en corte

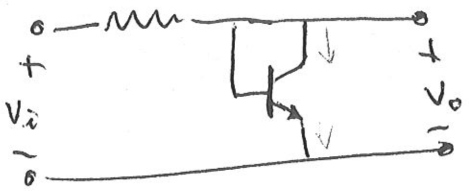


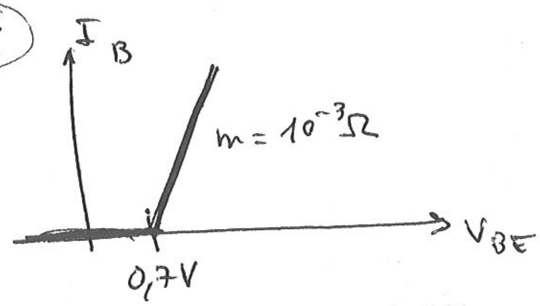
SAT : $I_B \cdot h_{FE} \geq I_{C\,sat} \approx \frac{12-0}{10k\Omega}$ } $R \leq 94\,k\Omega$

$I_B = \frac{12 - 0,7}{R}$

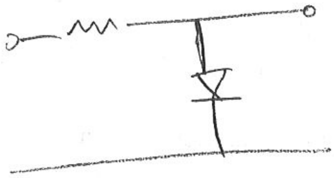
Prob. 5 (2)

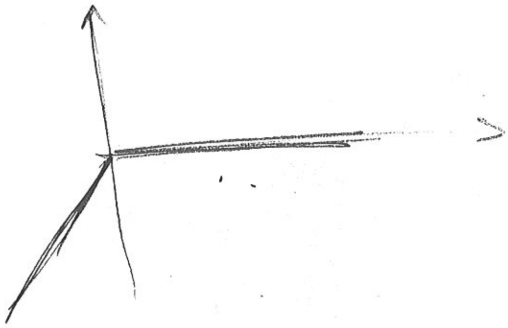
CCE



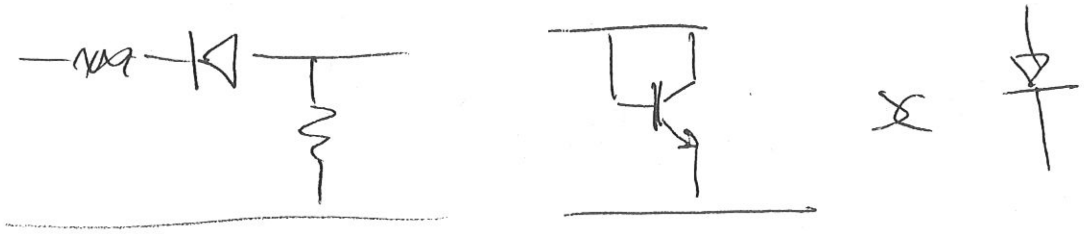


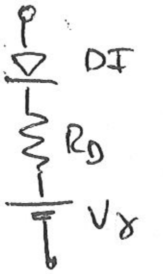
h_{FE} $V_{CE\,sat} = 0,2\,V$

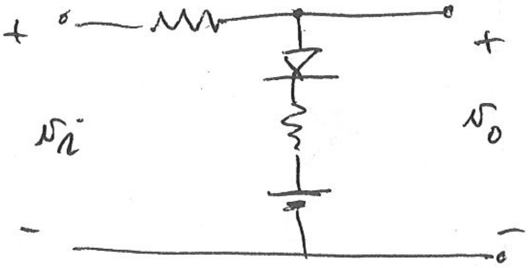




(b)



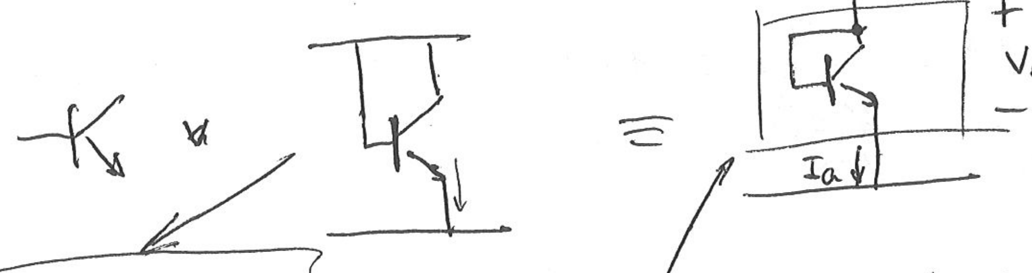




$m = \frac{1}{R_D} = 10^{-3}\,\Omega^{-1}$

$r_D = 1\,k\Omega$

* Uniendo la base i el emisor no puede estar en SATURACIÓN



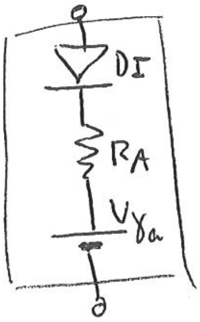
$V_{CE} = V_{BE}$

Dispositivo de 2 terminales

$I_a = I_E$

$V_a = V_{BE}$

- OFF ⇒ corte
- ON ⇒ activa



ELEF
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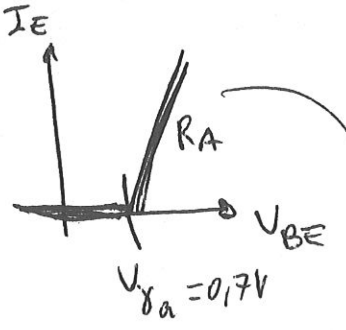


$V_{BE} = V_\gamma + R_0 \cdot I_B$

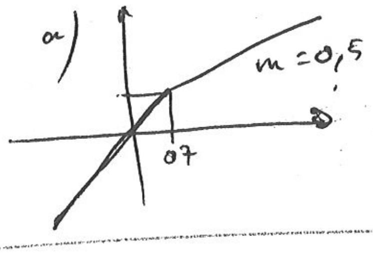
Modelo estático en ON.

ACTIVA : $V_{BE} = V_\gamma + R_0 \cdot I_B$

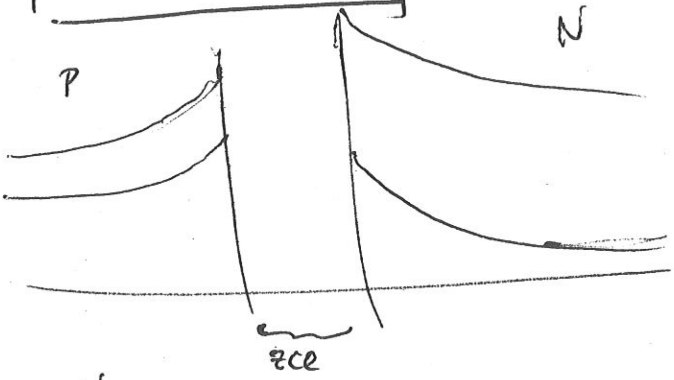
$V_{BE} = V_\gamma + \frac{R_0}{h_{FE}+1} \cdot I_E$

$h_{FE} = 99$

a)



PROBL. 6 (5)



⟹ En directa

Correcto:

* El campo eléctrico en la ZCE es inferior al existente en equilibrio.

Potencial de contacto : $V_0 = V_T \ln p_{p0}$ ...

SC EXTRÍNSEC (N, P) (IMPURIFICAT) [ ] = cm^{-3} (e^-, h^+ (FORATS))

$np = n_i^2(T)$ (LLEI ACCIÓ MASSES, T = TEMPERATURA)

$\sigma = q_e \cdot (\mu_p \cdot p + \mu_n \cdot n)$ (CONDUCTIVITAT, $q_e = 1{,}6 \cdot 10^{-19}$ C, μ en $cm^2/V \cdot s$; DENSITAT CORRENT $(\Omega cm)^{-1}$)

SC INTRÍNSEC (PURA) [ ] e^-, h^+

$n = p = n_i(T)$ cm^{-3} $\quad \sigma = q_e \cdot n_i \cdot (\mu_p + \mu_n)$ (CONDUCTIVITAT (Ωcm^{-1}))

[ ] IMPURESES (DONADORES, ACCEPTADORES) cm^{-3}

$N_d + p = N_a + n$ cm^{-3} (LLEI NEUTRALITAT CÀRREGA; N_a: ACCEPTOR, N_d: DONADOR)

$\rho = \frac{1}{\sigma}$ Ωcm (RESISTIVITAT; σ: CONDUCTIVITAT) $\quad R = \rho \frac{l}{S}$ (RESISTÈNCIA Ω)

DOPAT DONADORS: $n >> p \rightarrow n \simeq N_D$ $\quad \sigma = q_e \cdot \mu_n \cdot N_D$ $\quad \sigma = \frac{1}{R} \frac{l}{S}$

$N_A = 0$

$J_{dn} = q_e \cdot D_n \cdot \frac{dn(x)}{dx}$ $A \cdot cm^{-2}$ (CORRENT DIFUSIÓ e^-)

$J_{an_p} = q_e \cdot \mu_{n_p} \cdot n(x) \cdot E(x)$ (CAMP ELÈCTRIC; σ)

$J_{dp} = -q_e \cdot D_p \cdot \frac{dp(x)}{dx}$ (DENSITAT CORRENT DIFUSIÓ h^+)

$J_{an_p} = -J_{dn_p}$ (EQUILIBRI)

$V_1 - V_2 = V_T \cdot \ln \frac{n_1}{n_2}$

$V_T = \frac{D_{n_p}}{\mu_{n_p}} = \frac{KT}{q_e}$ (POT. EQUIVALENT TEMP.; CONSTANT DIFUSIÓ; RELACIÓ EINSTEIN)

$V_0 = V_T \cdot \ln \frac{N_a \cdot N_d}{n_i^2}$ (POTENCIAL DE CONTACTE)

$W_0 = \sqrt{\frac{2\varepsilon}{q_e}\left(\frac{1}{N_a} + \frac{1}{N_d}\right) \cdot (V_0 - V)}$ μm (AMPLADA ZCE; $\varepsilon = \varepsilon_r \cdot \varepsilon_0$ F/cm; V: TENSIÓ POLARITZACIÓ) → UNIÓ PN ABRUPTA POL.

$W_0 = W_n + W_p$ $\quad W_{n_p} = \frac{N_{a_d}}{N_a + N_d} W_0$

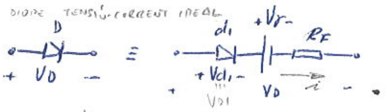
$J = \sigma \cdot E$ (LLEI OHM) $\quad E_m = -\frac{2V_0}{W_0}$ (CAMP E MÀXIM) $\quad V = RI$ $\quad E = -\frac{dV}{dx}$

$I_S = q_e \cdot A \cdot n_i^2 \left(\frac{D_p}{L_p} \cdot \frac{1}{N_d} + \frac{D_n}{L_n} \cdot \frac{1}{N_a}\right)$ (CORRENT INVERS SATURACIÓ; A: ÀREA)

$L_p = \sqrt{D_p \cdot \tau_p}$ $_{(n)}$ cm/s (ZONES NEUTRES) $\quad L_{p(n)} = X_p - W_p$ μm $\quad R_p = \frac{1}{\sigma} \cdot \frac{L_p}{A}$

$C_T = A \cdot \frac{\varepsilon}{W}$ F (CAPACITAT TRANSICIÓ)

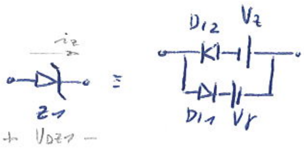
DIODE TENSIÓ-CORRENT IDEAL



IDEALS ($V_\gamma = 0$, $R_f = 0$)

DON ($i > 0$, $V_{D1} = 0$)

DOFF ($i = 0$, $V_{D1} < 0$)



DZ: ON: $V_{dz} = V_\gamma$, $i > 0$; OFF: $-V_z < V_{DZ} < V_\gamma$, $i = 0$; ON: $V_{dz} = -V_z$, $i < 0$

$V_i = V_{ef}\sqrt{2} \sin \omega t$ (TENSIÓ ENTRADA; $V_{màx} = V_{ef}\sqrt{2}$)

$S_{dc} = \frac{1}{T}\int_0^T s(\alpha)\, d\alpha$ (VALOR MITJÀ SENYAL PERIÒDIC; I; T (PERÍODE); $I_{màx} \sin \omega t \, d(\omega t)$)

$I_{ef} = \frac{I_{màx}}{\sqrt{2}}$ $\quad V_{ef} = \frac{V_{màx}}{\sqrt{2}}$ $\quad V_{oef} = \frac{V_{o\,pic}}{\sqrt{2}}$

$P = \frac{1}{2\pi}\int_0^{2\pi} V_i \cdot i \, d\alpha$ (POT. MITJÀ)

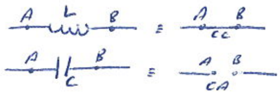
$P_{màx} = V \cdot I_{màx}$

$S_{ef} = \sqrt{\frac{1}{T}\int_0^{2\pi\,(T)} s^2(\alpha)\, d\alpha}$ (VALOR EFICAÇ; $I_{D\,ef}$; $i_D^2\, d(\omega t)$; $i = I_{màx} \cdot \sin \alpha$, $d\omega t$)

$\Delta V_0 = \frac{V_m}{R_L C f} = \frac{I_{odc} \cdot V_m}{V_{odc} \cdot C \cdot f}$ (ARRISSAMENT DE TENSIÓ; R_L: RESISTÈNCIA DE CÀRREGA)

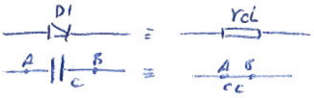
$V_{odc} = V_m - \frac{\Delta V_0}{2}$ (VALOR MITJÀ TENSIÓ SORTIDA; V_m: TENSIÓ PIC (SORTIDA))

1. DC: I_{DQ}, V_{DQ} → r_d



$I_{DQ} = I_S \left(e^{\frac{V_{DQ}}{n V_T}} - 1\right)$ $\quad r_d = \frac{n V_T}{I_{DQ}} = \frac{1}{\left.\frac{di_D}{dv_D}\right|_Q} = \frac{1}{m}$

2. AC: i_d, V_d (PETIT SENYAL)



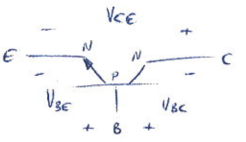
$i_D = I_{DQ} + i_d$

$V_D = V_{DQ} + v_d \rightarrow v_d = V_D - V_{DQ}$

$V_d = r_d \cdot i_d$

$I_C = \beta \cdot I_B$

$I_E = (\beta + 1) \cdot I_B$



$V_{BE} > 0$ directa; $V_{BC} < 0$ inversa → ACTIVA ($I_C < I_{C(sat)}$; $V_{CE} < V_{CE(sat)}$)

APROXIMACIÓ LINEAL PER TRAMS.

$I = I_S \left(e^{V/V_T} - 1\right)$

PTO Q: (I_B, I_C, V_{BC})

1. $V_{CE} = V_{CC} - I_C R_C$ $\quad V_{CE} = V_{CB} + V_{BE}$ $\quad V_{CE} = V_C - V_E$
2. $I_C = \beta \cdot I_B$ ($h_{FE} = \beta$) $\quad I_E = I_C + I_B$
3. $I_B = \frac{V_{BB} - V_{CE}}{R_B}$

·TRT EN ACTIVA: $(V_{BE} = 0{,}7V)$ $\quad V_{BE} > 0$ DIRECTA, $V_{BC} < 0$ INVERSA.

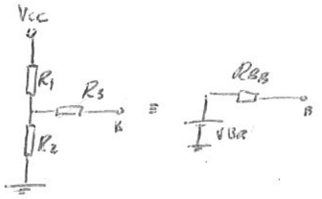
$I_C = \beta \cdot I_B$

$I_E = (\beta + 1) I_B$

·TRT EN SAT: $I_C > I_{C(SAT)}$ $\quad V_{BE} > 0$ DIRECTA, $V_{BC} > 0$ DIRECTA.

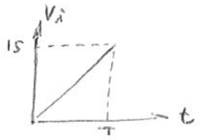
$I_{C(SAT)} = \frac{V_{CC}}{R_C}$

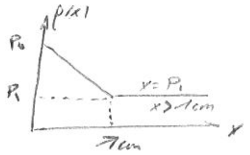
$\beta_1 = \beta_2 = 100 \rightarrow \beta + 1 \simeq \beta \rightarrow I_E \simeq I_C = I_B \cdot \beta$

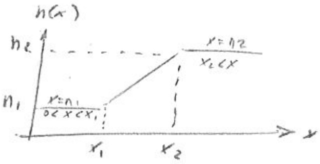


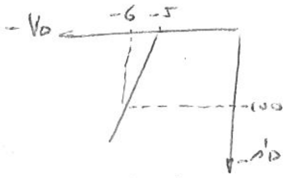
$$R_{BB} = \frac{R_1 R_2}{R_1 + R_2} + R_3$$

$$V_{BB} = R_2 \frac{V_{CC}}{R_1 + R_2}$$









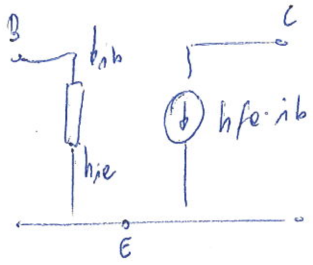
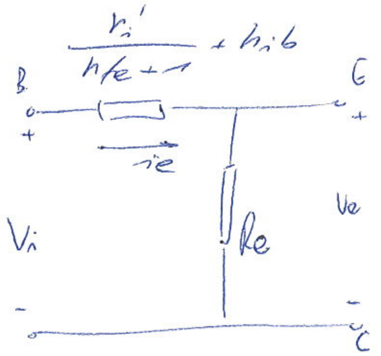
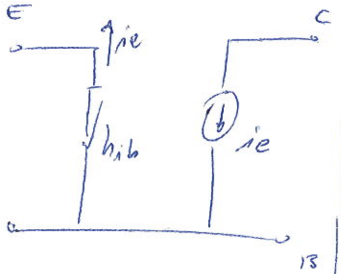
$V_i = \frac{15}{T} t \quad 0 \le t \le T$

$\rho_0 + (\rho_1 - \rho_0) x \quad 0 < x < 1cm$

$\frac{n_2 - n_1}{x_2 - x_1} (x - x_1) + n_1 \quad x_1 \le x \le x_2$

$i_D = 100 V_D + 500 \quad V_D < -5V$

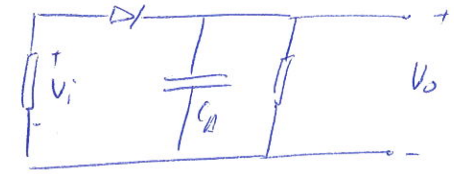
Tabla de parámetros importantes de las tres configuraciones básicas. (BJT)

	EC	CC (Seguidor de emisor)	BC
Ganancia	$A_i \approx -h_{fe}$	$A_v \approx 1$	$A_i \approx -h_{fb} = \frac{h_{fe}}{1+h_{fe}}$
Impedancia de entrada	$h_{ie} = \frac{25\cdot 10^{-3} h_{fe}}{I_{EQ}}$	$Z_i = h_{ie} + (h_{fe}+1)R_E$	$h_{ib} = \frac{h_{ie}}{1+h_{fe}}$
Impedancia de salida	$\frac{1}{h_{oe}} > 10^4 \Omega$	$Z_o \approx h_{ib} + \frac{r_i}{h_{fe}+1}$	$\frac{1}{h_{ob}} = \frac{1+h_{fe}}{h_{oe}}$
Circuito equivalente + sencillo			

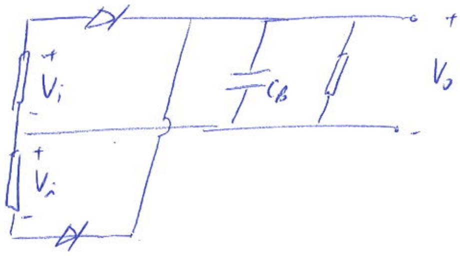
Parametros híbridos . h :

Solucion TEST F.95

1/



$V_i = V_m \sin wt$



a/ C_A ΔV_o b cierto

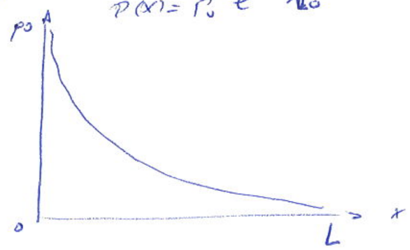
b/ $\Delta V_{oA} = \Delta V_{oB} \Rightarrow C_A > C_B$. cierto

c/ $Vd_{inv\ maxB} \simeq Vd_{inv\ maxA} \simeq -2V_m$. cierto

d/ $V_{oef_A} = \frac{V_m}{2}$ $V_{oef_B} = \frac{V_m}{\sqrt{2}}$. Falso

$V_o \simeq$ continua.

2/ $p(x) = p_0 e^{-x/L_0}$



S.C. aislado y en equilibrio produce E.

NO a/ positivo. $\frac{dp(x)}{dx} < 0 \Rightarrow J_{dp} > 0$

$J_{an} < 0$

E hacia la izquierda

SI b/ negativo y constante.

NO c/ lineal con x.

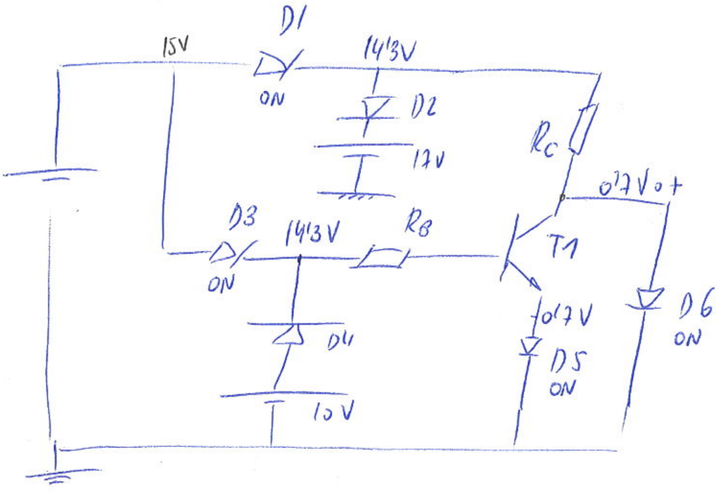
No d/ nulo $\Rightarrow J_a = 0$ y $J_{dp} \neq 0$ debe anularse en equilibrio

→ b/ $J_{ap} = J_{dp} \Rightarrow$

$\Rightarrow q\mu_p p E = q D_p \frac{dp(x)}{dx} \rightarrow E = \frac{D_p}{\mu_p} \frac{1}{p} \frac{dp}{dx}$

$E = cte \cdot \frac{e^{-x/L_0}}{e^{-x/L_0}}$

3/

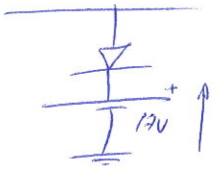


$V_\gamma = 0'7$ en D

$V_{CE\,sat} = 0'2$ V

$V_{BE\,act} = 0'7$ V

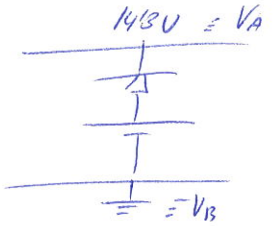
D_2 OFF. no conduce:



- diodo en contra de la i.

D_4 OFF. tensiones diferentes

$V_A > V_B$



T1

→ D1 ON, D2 OFF, D3 ON, D4 OFF, D5 ON, D6 ON, T1 SAT.

Tensión en $V_{D6} = 0'7V$ xq D_6 ON

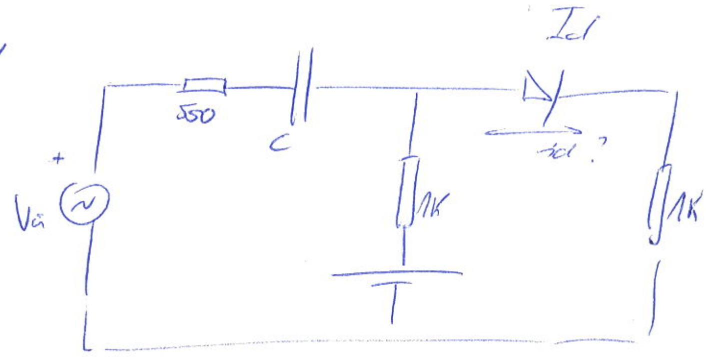
$I_C < \beta I_B$

$V_{CE_{T1}} = V_C - V_E = 0'7 - 0'7 \approx 0V$

$V_C \leq V_{CE_{SAT}}$

Activa ⟺ $V_{CE} > 0 = V_{CE_{SAT}}$

4/



No a/ $i_d = 5 - 0'005 \sin wt$ mA

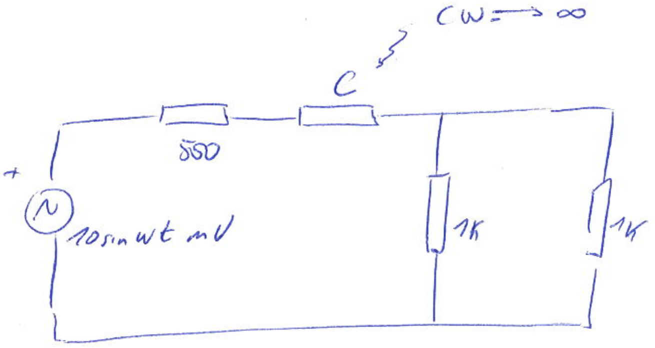
No b/ $= -5 + 0'005 \sin wt$

Sí c/ $5 + 0'005 \sin wt$

No d/ 5mA

b → id negativa ; id < 0

d → falta V_i

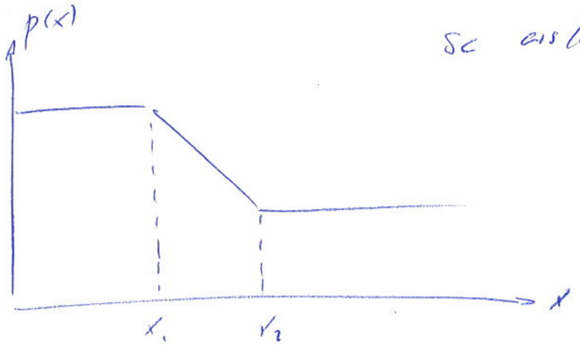


$$\frac{10\,mV}{1K} = 10\,\frac{mV}{K\Omega} = 10 \cdot 10^{-6} A$$

$$\frac{10\,\mu A}{2} = 5\,\mu A$$

$\underline{\underline{>0}}$

5/



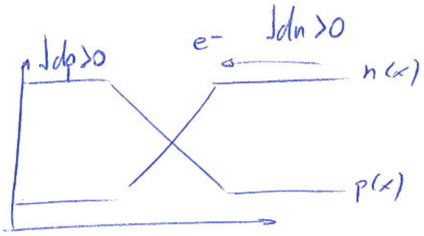
Sc aislado y en eq

a/ $J_{Total} = 0$ Cierto por definición de eq.

b/ $J_{op} > 0$, $J_{dp} > 0 \Rightarrow J_{op} < 0$ para contrarrestar J_{dp}

c/ J_d mismo signo J_{dn}

en eq: $n(x) = \frac{n_i^2}{p(x)}$



por lo tanto $J_d > 0$.

d/ J_{ap} mismo signo y valor que J_{an}

$J_{ap} = J_{an}$. Falso

$q \cdot \mu_p \cdot p \cdot E = q \cdot \mu_n \cdot n \cdot E$ $n \neq p$ (según gráfica (c))

6) SC tipo N: en una zona neutra

$\Delta p(x) = 10^{10} \frac{W-x}{W} \ cm^{-3}$

$W = 1mm = 10^{-1} cm$

$J_{dn}(x=0) = ?$

$J_{dn} = q D_n \frac{dn}{dx} = q D_n \frac{d\Delta n(x)}{dx} = 1'6 \cdot 10^{-19} \cdot 37'5 \left(\frac{-1}{10^{-1}} \cdot 10^{10} \right)$ ($10^{-1} = W$)

En zona neutra: $\Delta n(x) = \Delta p(x)$

$\mu_n = \frac{1500 \ cm}{Vs}$

$V_T = 0'025 \ V$

$D_n = \mu_n V_T = 37'5$

$I = J_{dn} \cdot A = -0'6 \ mA$

$A = 1cm^2$ (area)